REMARKS

Prior to this amendment, claims 1, 30-35, 37, 38, 40-44, 47-56, 58, 60-62, 64, and 65 were pending. Claim 37 has been canceled. Accordingly claims 1, 30-35, 38, 40-44, 47-56, 58, 60-62, 64, and 65 remain currently pending.

In the Office Action, claims 1 and 30-32 were rejected under 35 U.S.C. § 102(a) as being anticipated by Kawano et al. (U.S. Patent No. 6,066,558). Additionally, claims 33-35, 37, 38, 60-62, 64, and 65 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Kawano. Each of the rejections is addressed in detail below. Claim 37 has been canceled, rendering the objection thereto moot. Claims 40-44, 47-56, 58 were allowed.

Rejections Under 35 U.S.C. § 102

The Examiner rejected claims 1 and 30-32 under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,066,558 to Kawano et al. ("the Kawano reference"). Specifically, the Examiner stated:

> Claims 1, 30-32 are rejected under 35 U.S.C. 102(e) as being anticipated by Kawano, et al. (US 6,066,558).
>
> Kawano discloses forming on a semiconductor substrate having a contact, depositing a conductor layer (col. 6, lines 59-67), forming an impurity layer in the contact hole after about the last 30% of the conductor has been deposited (col. 7, lines 50-60), said impurity lowering the melting point of the conductor, and reflowing the conductor at a temperature to cause reflow (col. 8, lines 25-35 and col. 9, lines 22-40).

> The steps are performed in order (Fig. 2D-H). The temperature is within the recited range. The impurity is Ti(Fig. 2F).
>
> Office Action of May 27, 2004, page 3.

The Applicant respectfully traverse the rejection of the pending claims. Anticipation under section 102 can be found only if a single reference shows exactly what is claimed. *Titanium Metals Corp. v. Banner*, 778 F.2d 775, 227 U.S.P.Q. 773 (Fed. Cir. 1985). For a prior art reference to anticipate under section 102, every element of the claimed invention must be identically shown in a single reference. *In re Bond*, 910 F.2d 831, 15 U.S.P.Q.2d 1566 (Fed. Cir. 1990). To maintain a proper rejection under section 102, a single reference must teach each and every element or step of the rejected claim. *Atlas Powder v. E.I. du Pont*, 750 F.2d 1569 (Fed. Cir. 1984). Accordingly, the Applicant needs only to point to a single element not found in the cited reference to demonstrate that the cited reference fails to anticipate the claimed subject matter.

Independent claim 1 recites a method of processing a semiconductor substrate, the method comprising forming an impurity layer in said conductor layer "*only during about the last 30% of the deposition of the conductor layer*, said impurity layer *having a melting point temperature and surface tension less than that of said conductor*" and "heating the conductor layer to a reflow temperature."

The Kawano reference discloses "a multilevel interconnection forming method for forming a semiconductor device, in which aluminum filled in a hole connecting wiring by CVD

can be planarized." Kawano, col. 3, ll. 22-5. This multilevel interconnection forming method includes depositing a metal film on an insulating film of a substrate, forming an interlayer dielectric film on an entire layer of the substrate, forming a hole at a predetermined position of the interlayer dielectric film, and filling aluminum into the hole by a method such that aluminum is filled at a volume ratio *smaller than 100%* with respect to the hole. *Id.* at col. 3, ll. 29-41. The Kawano reference teaches that the hole is filled such that the uppermost end of the filling's convex portion is equal or lower than the level of the upper end opening portion of the hole. *Id.* at col. 7, ll. 51-4. However, the Kawano reference does not teach that the conductor layer is deposited in the hole for about the first 70% of the deposition before an impurity layer is formed in the conductor, as recited in claim 1.

Furthermore, the Kawano reference does not disclose an impurity *having a melting point temperature and surface tension less than that of the conductor*. The Examiner did not point to any passages in the Kawano reference that disclose the recitation set forth above and upon carefully reviewing the Kawano reference the Applicant is unable to find such disclosure. The Kawano reference refers to a metal film being formed on the entire surface of each wafer including the surface of the hole. The Examiner equates this metal film to the impurity layer formed in the depositing conductor layer, as recited in the instant claim. However, the metal film formed on the surface of each wafer, in Kawano, is just another conductor layer and not an impurity in the depositing conductor layer.

Additionally, even if the metal film in the Kawano reference could be correlated to the impurity layer recited in the instant claim, the metal in the Kawano reference is not indicated to

have a melting point temperature and surface tension less than that of the conductor. The Kawano reference does not teach or even suggest that the metal has a melting point temperature and surface tension less than that of the conductor, as recited in the instant claim. Therefore, the Applicant respectfully asserts that the Kawano reference fails to disclose all of the features recited in independent claim 1.

Independent claim 30 recites "depositing an impurity into the contact hole, *the impurity causing the melting point of the conductive material to lower*." The Examiner asserted that the Kawano reference discloses this element in col. 8, lines 25-35 and col. 9, lines 22-40. The cited passage states:

> In this reflowing process, aluminum alloy forming the metal layer 66 is heated, thereby causing fluidization of aluminum alloy, and aluminum alloy flows into the via hole 12 due to this fluidization. In this manner, the concave portion 68 is filed with aluminum alloy and the surface is planarized (see FIG. 2H). In this case, the volume of the concave portion 68 is very small due to existence of the plug 22, and therefore, the reflowing temperature may be set within a relatively low temperature range of, for example, about 350°C. to 420°C. The reflowing temperature is lower than the reflowing temperature (e.g., 450° C.) adopted in a conventional filling method. Therefore, organic material having a low dielectric constant, which has a low heat resistance, can be used for forming an interlayer dielectric film.

The Applicant respectfully asserts that the above passage cited by the Examiner is directed to the process of reflowing the conductor. The cited passage describes that, in this reflowing process, aluminum alloy is heated to a reflow temperature that is lower than the temperature conventionally used for reflowing. The Kawano reference explains that reflow occurs at a lower reflow temperature because the volume of the concave portion at the upper

most end of the hole is very small. However, the Kawano reference does not teach or suggest that the impurity deposited on the conductor layer in the hole causes the melting point of the conductive material to lower. Accordingly, the Kawano reference does not anticipate independent claim 30 and the claims dependent thereon.

For at least these reasons, Kawano does not anticipate the Applicant's present claims. Accordingly, the Applicant respectfully requests withdrawal of the rejections under Section 102 based on the Kawano reference.

Rejections Under 35 U.S.C. § 103

The Examiner rejected claims 33-35, 37, 38, 60-62, 64, and 65 under 35 U.S.C. § 103(a) as being unpatentable over Kawano. Specifically, the Examiner stated:

> Kawano is silent with respect to migration out of the contact hole and about the degree of lowering of the melting point and of the impurity not forming an alloy.
>
> With respect to the formation of an alloy, because the reflow is at a low temperature, it would have been obvious to one of ordinary skill in the art at the time of the invention that the impurity would not have formed an alloy because of the low temperature of the reflow.
>
> With respect to the degree of lowering of the melting point, because Kawano teaches Ti, it would have been obvious to one of ordinary skill in the art to expect the recited degree of lowering of the melting point, because Ti is one of the impurities disclosed by applicant. With respect to migration out of the contact hole, this is within the ordinary skill in the art to choose the impurity with the desired properties, as Kawano teaches that other impurities may be used (col. 8, lines 25-38).
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> Office Action dated May 27, 2004, page 4.

The Applicant respectfully traverses this rejection. The burden of establishing a *prima facie* case of obviousness falls on the Examiner. *Ex parte Wolters and Kuypers*, 214 U.S.P.Q. 735 (PTO Bd. App. 1979). Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention absent some teaching or suggestion supporting the modification. *See ACS Hospital Systems, Inc. v. Montefiore Hospital*, 732 F.2d 1572, 1577, 221 U.S.P.Q. 929, 933 (Fed. Cir. 1984). The mere fact that a references can be modified does not render the resultant modification obvious unless the prior art also suggests the desirability of the modification. *In re Mills*, 916 F.2d 680, 16 U.S.P.Q.2d. 1430 (Fed. Cir. 1990). Accordingly, to establish a *prima facie* case, the Examiner must not only show that the modified reference includes *all* of the claimed elements, but also a convincing line of reason as to why one of ordinary skill in the art would have found the claimed invention to have been obvious in light of the teachings of the reference. *See Ex parte Clapp*, 227 U.S.P.Q. 972 (B.P.A.I. 1985). The Examiner must provide objective evidence, rather than subjective belief and unknown authority, of the requisite motivation or suggestion to modify the cited reference. *In re Lee*, 61 U.S.P.Q.2d. 1430 (Fed. Cir. 2002).

The Examiner contends that claims 33-35, 38, 60-62, 64, and 65 would have been obvious to one of ordinary skill in the art based on the Kawano reference. However, the Examiner has presented no evidence to support this contention. Essentially, the Examiner has taken Official Notice of alleged facts by contending that various elements missing from the Kawano reference would have been obvious to a skilled artisan. Therefore, in accordance with M.P.E.P. § 2144.03, the Applicant hereby seasonably traverses and challenges the Examiner's use of Official Notice. Specifically, the Applicant respectfully requests that the Examiner

produce evidence in support of the Examiner's position as soon as practicable during prosecution and that the Examiner add a reference to the rejection. If the Examiner finds such a reference and applies it in combination with the Kawano reference, the Applicant further requests that the Examiner specifically identify the portion of the newly cited reference that discloses the elements allegedly within the ordinary skill in the art, as discussed above, or withdraw the rejection. For at least these reasons, the Applicant respectfully requests the withdrawal of the rejection of claims 33-35, 37, 38, 60-62, 64 and 65 under Section 103 based on the Kawano reference.

Furthermore, the Applicant notes that dependent claims 33-35 and 38 depend from independent claim 30. With this in mind, the Applicant respectfully reiterates that claim 30 is allowable for the reasons set forth above. Accordingly, the dependent claims 33-35 and 38 are also allowable.

Independent claim 60 recites, "depositing an *impurity* into the contact hole onto the conductive material at a temperature that causes the conductive material to reflow, wherein the *impurity causes the surface tension of the conductive material to lower* and wherein the *impurity does not form an alloy* with the conductive material." The Examiner did not point to any passages in the Kawano reference that disclose the recitation set forth above and upon carefully reviewing the Kawano reference the Applicant is unable to find such disclosure. As discussed above, the Kawano reference does not disclose depositing an impurity into the contact hole and it does not teach that the *impurity causes the surface tension of the conductive material to lower.* Additionally, Kawano fails to contain any teaching, suggestion or illustration that an impurity

does not form an alloy with the conductive material. Accordingly, independent claim 60 and the claims dependent thereon are not obvious in view of the Kawano reference.

Conclusion

In view of the amendments and remarks set forth above, the Applicant respectfully requests withdrawal of all of the Examiner's rejections. Furthermore, the Applicant asserts that an indication of the allowability of claims 1, 30-35, 37, 38, 40-44, 47-56, 58, 60-62, 64, and 65 is appropriate. If the Examiner believes that a telephonic interview will help speed this application toward issuance, the Examiner is invited to contact the undersigned at the telephone number listed below.

Respectfully submitted,

Date: August 11, 2004

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☒ Response to Office Action dated May 27, 2004 ☐ Final Rejection
☒ Other Amendment and Response, Postcard

☐ Assignment enclosed ☒ Cert. Of Timely Mailing ☐ Express Mail

Identification of Application:
Serial No. 09/901,837
Title LOW TEMPERATURE REFLOW METHOD FOR FILLING HIGH ASPECT RATIO CONTACTS
Applicant Shubneesh Batra et al.
Client Micron Technology, Inc.
File No. MCRO:199-3/FLE (95-0057.03) Attorney Michael G. Fletcher/BLT
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